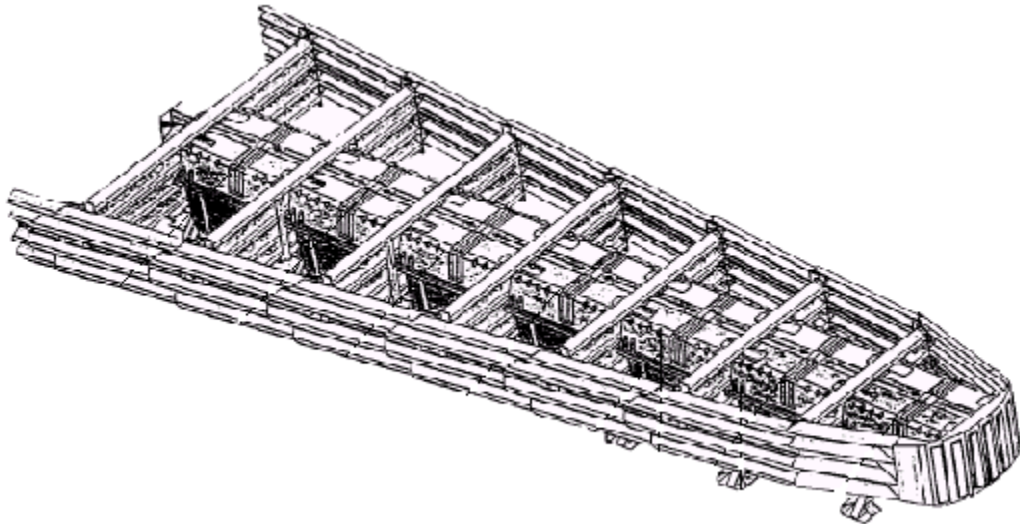
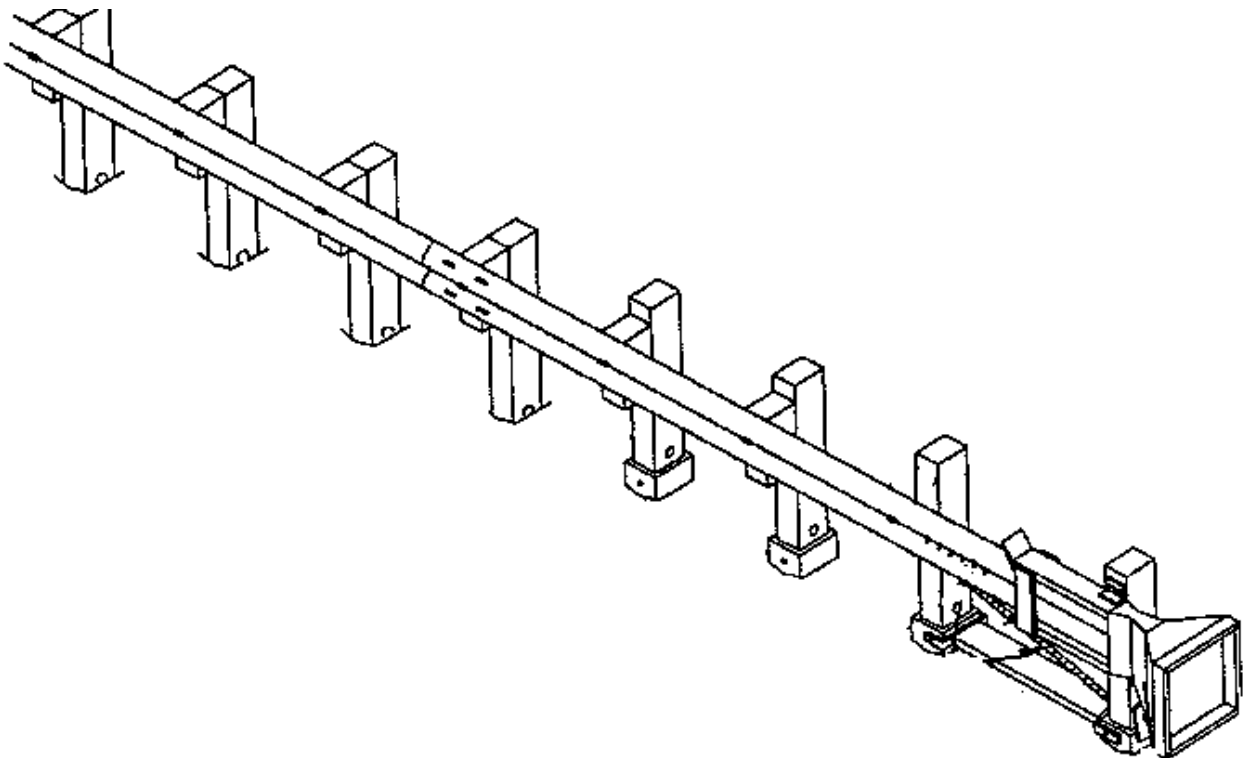




UTAH DEPARTMENT OF TRANSPORTATION



Guidelines for **CRASH CUSHIONS**



UTAH DEPARTMENT OF TRANSPORTATION

**GUIDELINES FOR
CRASH CUSHIONS**

&

APPROVED PRODUCTS LIST

PREPARED BY THE DIVISION OF TRAFFIC & SAFETY

DATED **MAY 1, 2003**

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UDOT GUIDELINES FOR CRASH CUSHIONS

INTRODUCTION

May 1, 2003

UDOT has adopted NCHRP 350 testing Basic TL-3 as the standard for crash cushions. Testing is done using a minimum of two types of production model vehicles, a small car and a pickup truck at a nominal speed of 60 MPH. Each device must pass a minimum number of tests in order to receive FHWA certification as a compliant system. More information about the testing requirements can be found in NCHRP Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features. All systems listed in this guide have been approved for use on the State and National Highway Systems.

A designer may designate any one system for a project, when there is a choice of more than one system, but must submit a letter of public interest explaining why this is the preferred system. The letter will be sent to the Traffic & Safety Operations Engineer, Division of Traffic & Safety. The Traffic & Safety Operations Engineer will forward it, with recommendation, to the Federal Highway Administration for approval. The approved letter will be placed in the project file.

These guidelines will list the type of crash cushion, a brief description, and application of the system.

The Crash Cushion Type with the manufacturer's name and the local supplier will identify each system.

Systems identified as construction zone systems will not be used in a permanent application without prior approval from the Traffic & Safety Operations Engineer, Division of Traffic & Safety.

Each approved crash cushion will have the following information:

NCHRP Test Level: the level a system has passed NCHRP 350 testing.

TL-1 \leq 40 MPH

TL-2 \geq 45 MPH and \leq 55 MPH

TL-3 $>$ 55 MPH

Crash Cushion Types A, B, D and E can be configured to meet varying design criteria. Types C, F, G and H are all TL-3 systems.

LON: Length Of Need indicates that portion of the system that can be included as part of the barrier LON requirement.

Characteristics: the manner in which the system has been designed to perform.

Application: a statement that lists some of the appropriate uses, requirements and Standard Drawings applicable to the system.

Requirements: conditions needed to insure proper operation of the system. Special requirements may be needed to handle drainage, or specific grading requirements for the systems. If there are special circumstance or requirement contact the Traffic & Safety Operations Engineer.

Offset: (guardrail approved systems) the distance from the traveled way to the system.

SYSTEM TYPES & DESCRIPTION

Summary Table of Approved Crash Cushions For Permanent Application

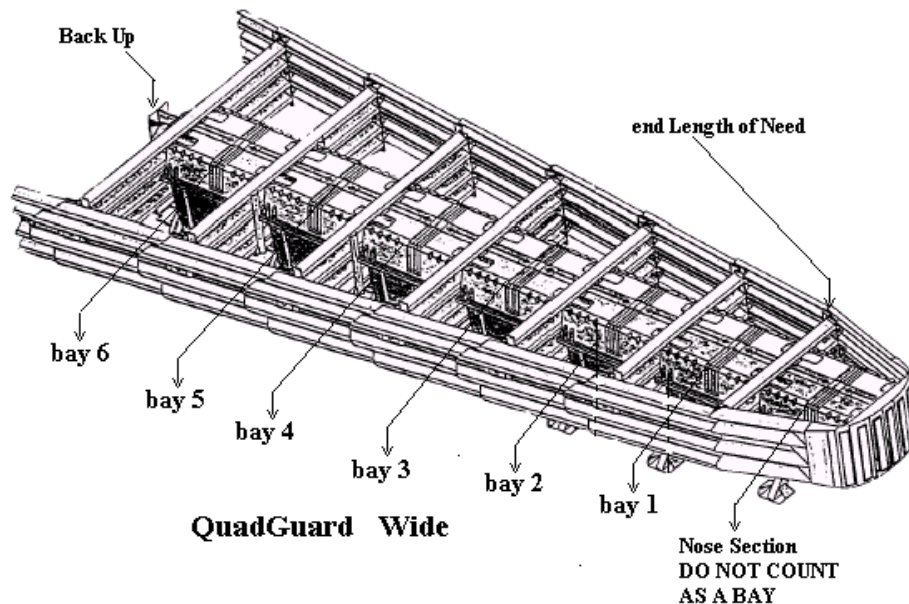
CRASH CUSHIONS		
Type A: Primarily to protect wide fixed hazards with limited recovery area, non gating system		
Name	Manufacturer	NCHRP Test Level
Quad Guard Wide	Energy Absorption Systems	TL-1, TL-2, TL-3
Type B: Primarily to protect narrow fixed hazards with limited recovery area, non gating system		
Name	Manufacturer	NCHRP Test Level
Quad Guard	Energy Absorption Systems	TL-1, TL-2, TL-3
Type C: Primarily to protect narrow hazards with available recovery area, gating system		
Name	Manufacturer	NCHRP Test Level
Brakemaster 350	Energy Absorption Systems	TL-3
CAT 350	Trinity Industries, Inc.	TL-3
Type D: Primarily to protect hazards with limited recovery area and high potential of impact, non gating system		
	Manufacturer	NCHRP Test Level
Quad Guard Elite	Energy Absorption Systems	TL-2, TL-3
Quad Guard LMC	Energy Absorption Systems	TL-3
REACT 350	Roadway Safety Service Inc.	TL-2, TL-3
Type E: Primarily to protect hazards a minimum of 15 feet from travel lane with available recovery area, gating system		
Name	Manufacturer	NCHRP Test Level
<u>Sand Barrels</u> "Big Sandy" Energite III Fitch Barrel	TrafFix Devices Inc. Energy Absorption Systems Roadway Safety Services Inc.	TL-1, TL-2, TL-3
Type F: Primarily to protect concrete barrier ends and bridge parapets with limited longitudinal space and available recovery area, gating system.		
Name	Manufacturer	NCHRP Test Level
Quad Trend 350	Energy Absorption Systems	TL-3
Type G: Primarily to protect guardrail approach ends on tangent guardrail installations with available recovery area, can be used to protect concrete barrier ends and bridge parapets when a transition element is used, gating system.		
Name	Manufacturer	NCHRP Test Level
ET 2000 / ET PLUS	Trinity Industries, Inc.	TL-3
SKT 350	Road Systems Inc.	TL-3
Type H: Primarily to protect guardrail approach ends on tangent or flared guardrail installations with available recovery area, can be used to protect concrete barrier ends and bridge parapet when a transition element is used, gating system.		
Name	Manufacturer	NCHRP Test Level
FLEAT 350	Road Systems Inc	TL-3
SRT 350 8 Post System	Trinity Industries, Inc.	TL-3
SRT/ HBA 6-Post System	Trinity Industries, Inc.	TL-3

TYPE A (1 approved system)

To protect fixed hazards greater than 60 inches wide within 15 feet of the traveled way, with less than 100 feet of longitudinal space in front of the hazard and a recover area behind the system is unattainable. Use to protect concrete barrier ends, bridge parapets or piers, and other hazards as a stand-alone system. A transition element is required to protect single or double-faced guardrail ends. These systems may be used on shoulders or in medians where a recovery area behind system and hazard is unattainable. These systems should be used in areas where minimal impacts are anticipated, one impact every three or more years.

Name: QuadGuard® Wide from Energy Absorption Systems

www.energyabsorption.com/products/permanent/quadguard_cen.htm



Length

Varies according to speed requirements, see NCHRP test level below

Width

2 standard widths: 69 inches and 90 inches

NCHRP Test Level

TL-1, ≤ 40 mph	2 bay, length	8' 9"
TL-2, 45 mph	3 bay, length	11' 9"
TL-2, 50 mph	4 bay, length	14' 9"
TL-2, 55 mph	5 bay, length	17' 9"
TL-3, > 55 mph	6 bay, length	20' 9" see note

Note: The manufacturer's design manual for this system list more bays for higher levels of speed. However these systems exceed the requirements set by FHWA and are not required for use. A six bay system is all that is required for speeds greater than 55 mph.

Length of Need

From rear of nose section

Characteristics

Re-directive, bi-directional, unidirectional, non-gating, non-pocketing. System is equipped with two types of Hex Foam cartridges that absorb energy from an impacting vehicle. The fender panels redirect an impacting vehicle.

This system may be retrofitted to meet the requirements of the Type D, QuadGuard Elite System requirements, when repair history indicates a benefit would be realized.

Application

For fixed objects within 15 feet of the traveled lane(s), with a width ranging from 60 inches to a maximum width of 90 inches, where there is less than 100 feet of clear area in front of hazard, and the recovery area on the backside of the system is less than 75 feet x 20 feet.

This system can be used to protect concrete barrier, hazards in gore areas, lighting and sign structures, bridge parapets, piers, and as a stand-alone system. Transition elements are required for use with single and double-faced guardrail.

This system should be used in areas where minimal impacts are anticipated (one impact every three or more years).

Requirements

The area in front of the system will have a slope of 10:1 or less and be free of any obstacles for a minimum of 50 feet. The slope to the sides of the system, from any travel lane, will be no greater than 10:1 and be free of any obstacles.

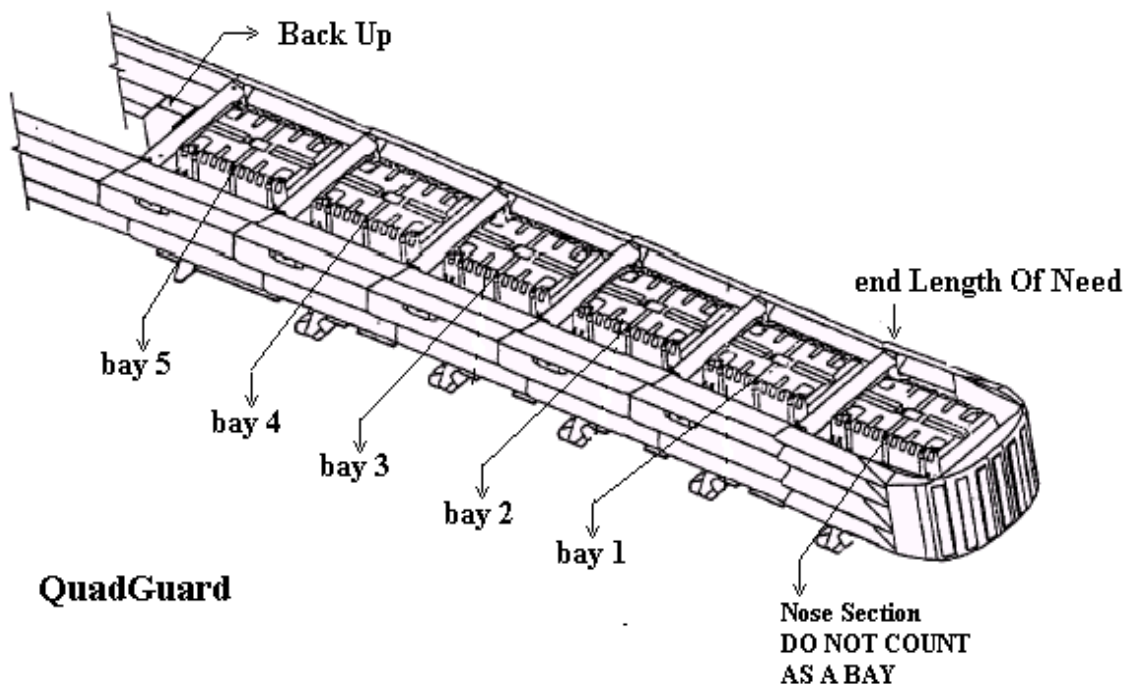
Refer to UDOT STD DWG CC 4. See manufacturer's specifications for pad, backup and transition requirements. See STD DWG CC 2, Plan A2 or STD DWG CC 3 Guideline B, where drainage requirements are needed. It is critical the proper cartridge is in the proper bay. The nose compartment uses a Type I cartridge in all applications. The manufacturer, supplier, or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD. DWG CC 1.

Type B (1 approved system)

To protect fixed hazards less than 3 feet wide within 15 feet of traveled way, with less than 100 feet of longitudinal space in front of the hazard and a recovery area on the backside of the system is unattainable. Use to protect concrete barrier ends, bridge parapets or piers, and other hazards as a stand-alone system. A transition element is required to protect single or double-faced guardrail ends. These systems may be used on shoulders or in medians. These systems should be used in areas where minimal impacts are anticipated (one impact every three or more years).

Name: QuadGuard® from Energy Absorption Systems

www.energyabsorption.com/products/permanent/quadguard_cen.htm



Length: Varies according to speed requirements, see test level below.

Width: Three standard widths: 24 inches, 30 inches and 36 inches

NCHRP Test Level:

TL-2, 45 mph	3 bay, length	11' 9"
TL-2, 50 mph	4 bay, length	14' 9"
TL-2, 55 mph	5 bay, length	17' 9"
TL-3, > 55 mph	6 bay, length	20' 9" <i>see note below</i>

Note: The design manual for this system list more bays for higher levels of speed. However these systems exceed the requirements set by FHWA and are not required for use. A six bay system is all that is required for speeds greater than 55 mph.

Length of Need: Rear of the nose section

Characteristics

Re-directive, bi-directional, unidirectional, non-gating, non-pocketing.

System is equipped with two types of Hex Foam cartridges that absorb energy from an impacting vehicle. The fender panels redirect an impacting vehicle.

This system may be retrofitted to meet the requirements of the Type D, QuadGuard Elite System requirements, when repair history indicates a benefit would be realized.

Application

For fixed objects within 15 feet of the traveled lane(s), with a width ranging from 24 inches to a maximum width of 36 inches, where there is less than 100 feet of clear area in front of hazard and the recovery area behind system is less than 75 feet x 20 feet. The area in front of the system will have a slope of 10:1 or less and be free of any obstacles. The slope to the sides of the system, from any travel lane, will be no greater than 10:1 and be free of any obstacles. Refer to UDOT STD DWG CC 4.

This system can be used to protect concrete barrier, hazards in gore areas, lighting and sign structures, bridge parapets, and piers as a stand-alone system. Transition elements are required for use with single and double-faced guardrail. When used with double-faced guardrail both sides of the system requires the use of two transition pieces attached to both sides of the guardrail runs.

This system should be used in areas where minimal impacts are anticipated (one impact every three or more years).

Requirements

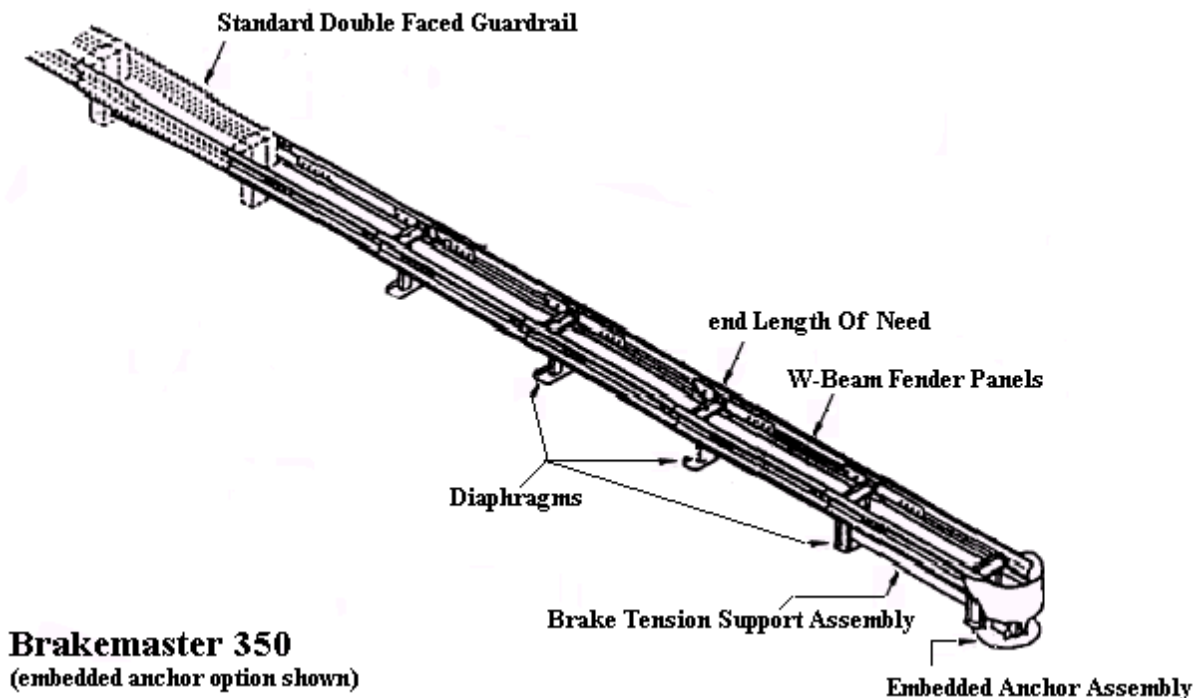
Refer to UDOT STD DWG CC 4 for all grading and placement requirements. See manufacturer's specifications for pad, backup and transition requirements. See STD DWG CC 2, Plan A2 or STD DWG CC 3 Guideline B, where drainage requirements are needed. It is critical the proper cartridge is in the proper bay. The nose compartment uses a Type I cartridge in all **applications**. The manufacturer, supplier, or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD. DWG CC 1.

Type C (2 approved systems)

To protect fixed objects 36 inches wide or less, within 15 feet of traveled way, and with longitudinal space in front of the hazard greater than 100 feet. Primarily used with double-faced guardrail. A transition element is required for concrete barrier or bridge parapet. These systems may be used on shoulders or in medians. Shoulder application requires a recovery area of 75 feet x 20 feet. Median application is required to have a recovery area of no less than 75 feet x 20 feet on both sides of the system. These systems should be used in area where minimal impacts are anticipated (one impact every three or more years).

Name: BRAKEMASTER® 350 from Energy Absorption Systems

www.energyabsorption.com/products/permanent/Brakemaster350System



Length: 31 feet 6 inches

Width: 2 feet 1 inch

Front Anchor Option:

This system is available with an embedded concrete anchor assembly, or a two-foundation tube anchor assembly. Both anchor assemblies are acceptable.

NCHRP Test Level: TL-3, may be used at any speed limit

Length of Need: Starting at diaphragm # 3, 16 feet from front of system

Characteristics

Gating, re-directive, bi-directional, uni-directional. This system rides above the ground and has no post. When this system is impacted head-on the braking system engages controlling the deceleration of the impacting vehicle to dissipate the energy of the impacting vehicle. This system has many parts that can be reused after impact; inspection should be completed prior to ordering replacement parts.

Application:

Shoulder: For fixed objects within 15 feet of the traveled lane and a width 24 inches or less, and where there is a minimum of 100 feet of clear area in front of hazard (150 feet when a transition element required to attach system to bridge parapet or concrete barrier).

Median: To protect fixed objects within 15 feet of the nearest approach lane and have a recovery area of 75 feet x 20 feet available before intrusion into the nearest opposing lane. A 10:1 slope is required, on both sides of the system. May be installed on concrete, asphalt, or soil surfaces. Refer to UDOT STD DWG CC 5.

Requirements

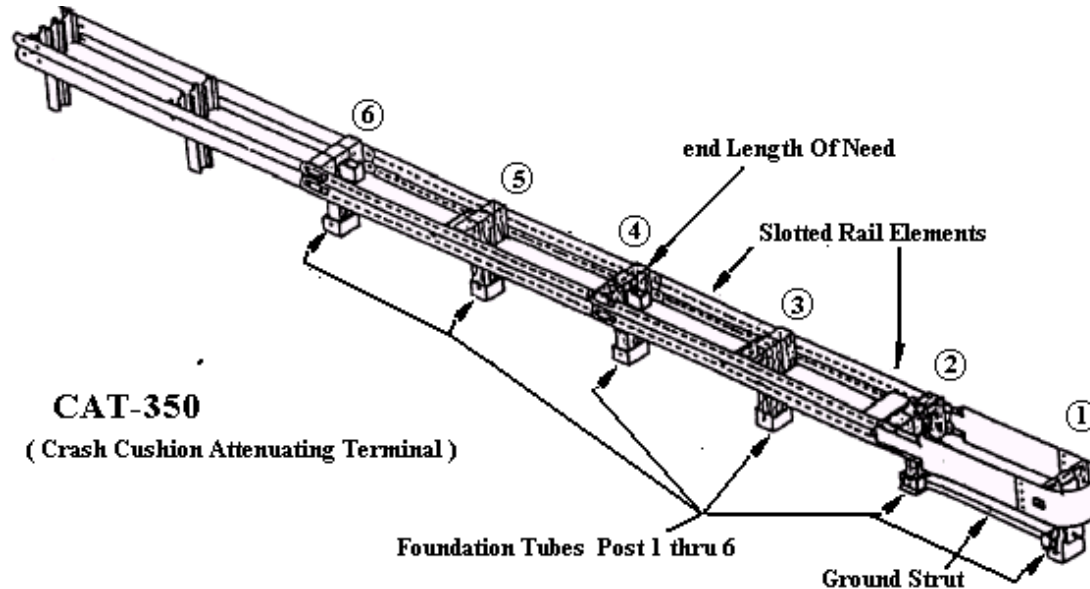
Transition requirements change for concrete barrier and bridge parapet, see manufacturer's specifications for proper transition element. The system attaches directly to single and double-faced guardrail. Refer to manufacturer's installation instructions for front anchor assembly requirements. The approach to the front of the system requires a slope of no greater than 10:1 for a length of 50 feet, and is free of any obstacles. The approach slope from the travel lane(s) to the side(s) of the system is required be no greater than 10:1 and be free of any obstacles. The recovery area behind the system will not be less than 75 feet x 20 feet, and on a slope no greater than 4:1, refer to UDOT STD DWG CC 5. The manufacturer, supplier or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD DWG CC 1.

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Type C (continued)

Name: C.A.T. 350™ from Syro, Inc., A Trinities Industries Co.

www.highwayguardrail.com



Length: 31 feet 3 inches

Width: 2 feet

NCHRP Test Level: TL-3, may be used at any speed limit

Length of Need: Starting at post # 4, 18 feet 9 inches from front of system

Characteristics

Gating, re-directive, bi-directional, and unidirectional. When this system is impacted head-on the slotted guardrail is forced over pins, which shear the rail. This shearing dissipates the energy of the impact, along with the CRT post. Soil tubes with soil plates required. This is a sacrificial system, many of the components must be replaced after an impact.

Applications

Shoulder: For fixed objects within 15 feet of the traveled lane and a width 24 inches or less and where there is a minimum of 100 feet of clear area in front of hazard (150 feet when a transition element is required to attach system to bridge parapet or concrete barrier). The approach to the front of the system requires a slope of no greater than 10:1 for a length of 50 feet, and free of any obstacles. The approach slope from the travel lane to the side of the system is required be

no greater than 10:1 and be free of any obstacles. The recovery area behind the system will not be less than 75 feet x 20 feet, and on a slope no greater than 4:1.

Median: To protect fixed objects within 15 feet of the nearest approach lane and have a recovery area of 75 feet x 20 feet available before intrusion into the nearest opposing lane. The approach to the front of the system requires a slope of no greater than 10:1 for a length of 50 feet, and free of any obstacles. A 10:1 slope is required, on both sides of the system. May be installed on concrete, asphalt, or soil surfaces. Refer to UDOT STD DWG CC 5.

Requirements

Transition requirements are different for concrete barrier and bridge parapet. See manufacturer's specifications for proper transition element. The system attaches directly to single and double-faced guardrail. The manufacturer, supplier, or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD DWG CC 1.

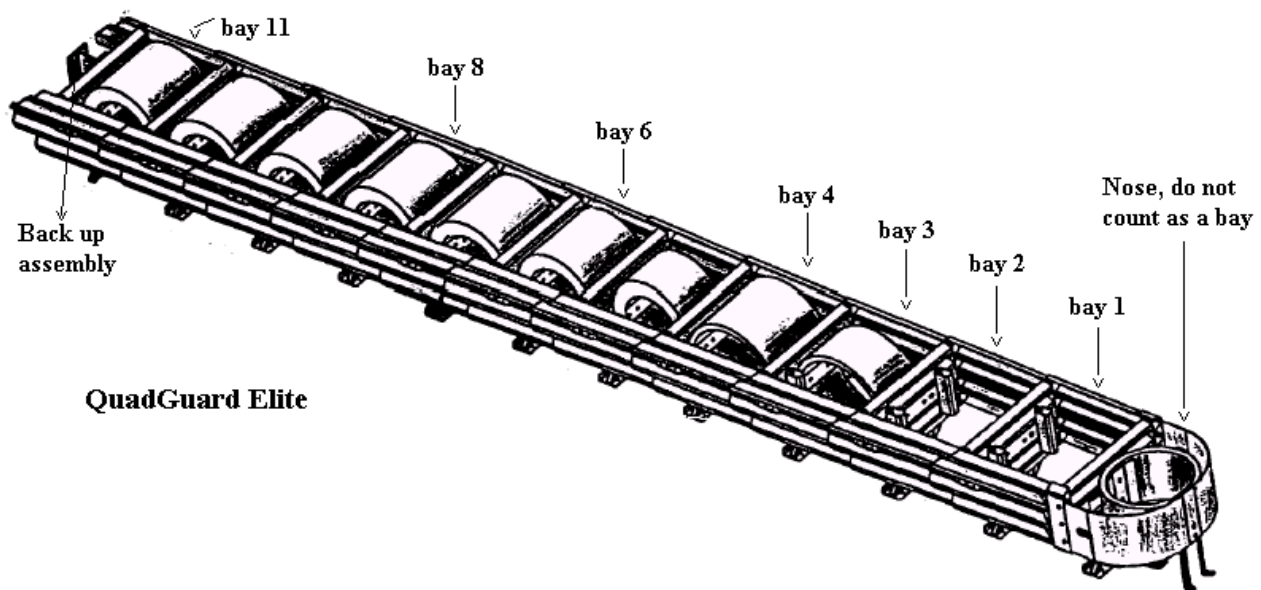
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Type D (3 approved systems)

To protect fixed hazards within 15 feet of traveled way, with less than 100 feet of space in front of the hazard. Used to protect concrete barrier ends, bridge parapets or piers, or other hazards as a stand-alone system. A transition element is required for use with single and double face guardrail. These systems may be used on shoulders or in medians. **These systems should be used in areas where more than one impact per year is anticipated or when repair history indicates two or more impacts over a three-year period.**

Name: QuadGuard® ELITE from Energy Absorption Systems

www.energyabsorption.com/products/permanent/QuadGuardEliteSystem.htm



Length: Varies with speed requirements, see test level below

Width: Five standard widths: 24 inches, 30 inches, 36 inches, 60 inches, and 90 inches. The 60 inch and 90 inch systems flare out on both sides to obtain the required width at backup.

NCHRP Test Level

TL-2, ≤ 45 mph	7 bays, length 21 feet 6 inches
TL-3, > 45 mph	11 bays, length 33 feet 4 inches

Characteristics

Re-directive, bi-directional, unidirectional, non-gating, non-pocketing. This system uses polyethylene cylinders, of varying wall thickness, which compress upon impact absorbing the energy from the impacting vehicle. The cylinders will return to their original shape after system is reset. Bays 1 and 2 do not have

cylinders. The fender panels redirect an impacting vehicle. This system can withstand multiple impacts with minimal repair.

Application

To protect fixed objects within 15 feet of the traveled lane, with width up to 90 inches. The approach to the front of the system will have a slope of 1:10 or less and be clear of any obstructions for a minimum of 50 feet. The approach slopes on either side of the system will be 1:10 or less. Refer to UDOT STD DWG CC 4. This system should be used in areas where at least one impact per year is anticipated, or when repair history indicates two or more impacts over a three-year period.

Requirements

See manufacturer's specifications for pad, backup and transition requirements. See STD DWG CC 2, Plan A2 or STD DWG CC 3 Guideline B, where drainage requirements are needed. The manufacturer, supplier or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD DWG CC 1.

Note: The QuadGuard Elite and QuadGuard LMC are similar in appearance; the difference is the material the cylinders are manufactured with.

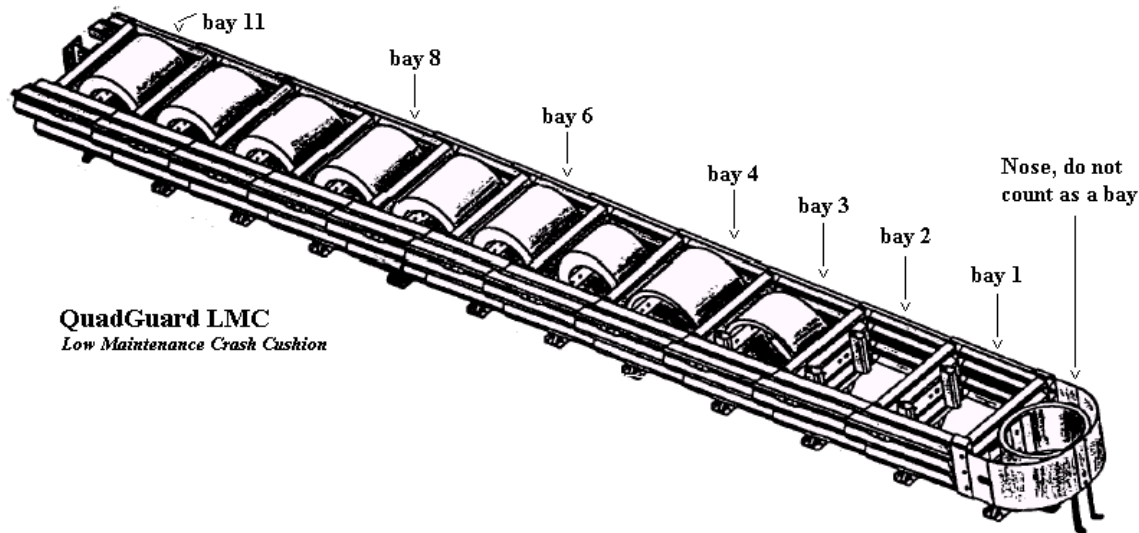
The cylinders from the QuadGuard Elite may be used to upgrade the standard QuadGuard systems (Types A and B) when required.

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Type D (continued)

Name: * QuadGuard® LMC from Energy Absorption Systems

www.energyabsorption.com/products/permanent/QuadGuardLMCSystem.htm



Length: 31 feet, this system is available in one length only

Width: Three standard widths: 36 inches, 60 inches, and 90". The 60 inch and 90 inch systems flare out on both sides to obtain the required width at backup.

NCHRP Test Level: TL-3, 11 bays (may be used with any speed)

Characteristics

Re-directive, bi-directional, unidirectional, non-gating, non-pocketing. This system uses elastomeric cylinders, of varying wall thickness, which compress upon impact absorbing the energy from the impacting vehicle. The cylinders will return to their original shape after system is reset. Bays 1 and 2 do not have cylinders. The fender panels redirect an impacting vehicle. This system can withstand multiple impacts with minimal repair.

Application

To protect fixed objects within 15 feet of the traveled lane, with widths up to 90 inches. This system should be used in areas where at least one impact per year is anticipated, or when repair history indicates two or more impacts over a three-year period.

Requirements

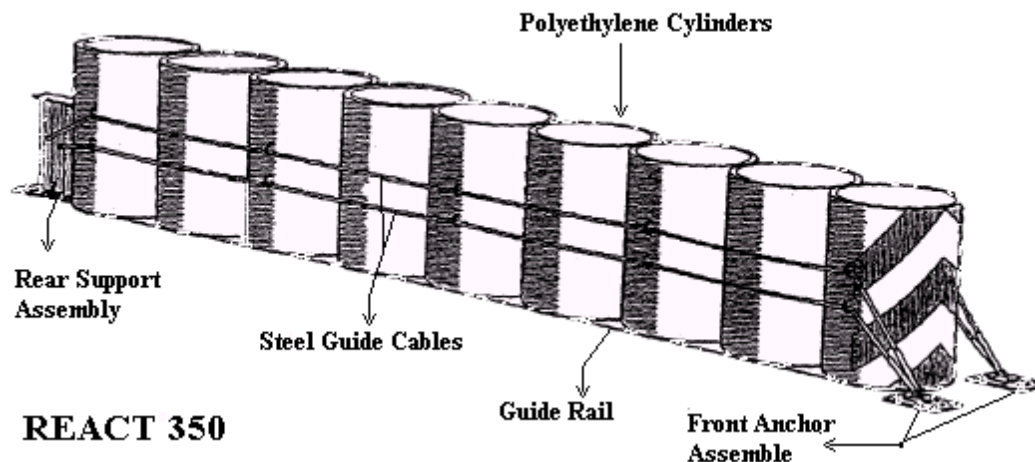
See manufacturer's specifications for pad, backup and transition requirements. The approach to the front of the system will have a slope of 10:1 or less and be

clear of any obstructions. The approach slopes on either side of the system will be 10:1 or less. Refer to UDOT STD DWG CC 4.

See STD DWG CC 2, Plan A2 or STD DWG CC 3 Guideline B, where drainage requirements are needed. The manufacturer, supplier or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD DWG CC 1.

* Note: The QuadGuard LMC and QuadGuard Elite are similar in appearance, the difference is the material the cylinders are manufactured with.

Name: REACT 350™ from Energy Absorption Systems,
www.energyabsorption.com/products/permanent/React350.htm



Length: Varies to speed requirements, see test level below

Width: 3 feet 11 inches

NCHRP Test Level

TL-2, \leq 45 mph	4 cylinders, length 15 feet 3 inches
TL-2, \geq 50 mph	6 cylinders, length 21 feet 3 inches
TL-3, \geq 60 mph	9 cylinders, length 30 feet 3 inches

Characteristics

Re-directive, bi-directional, unidirectional, non-gating, non-pocketing. This system uses polyethylene cylinders with varying wall thickness, which compress upon impact absorbing the energy from the impacting vehicle. The cylinders will return to approximately 80% of their original shape after impact. The cables used on this system give the system a re-directive capability. This system can withstand multiple impacts with minimal repair.

Application

To protect fixed objects within 15 feet of the traveled lane, with width up to 36 inches. This system should be used in areas where at least one impact per year is anticipated, or when repair history indicates two or more impacts over a three year period.

Requirements

See manufacturer's specifications for pad, backup and transition requirements. . The approach to the front of the system will have a slope of 1:10 or less and be clear of any obstructions. The approach slopes on either side of the system will be 1:10 or less. Refer to UDOT STD DWG CC 4. See STD DWG CC 2, Plan A2 or STD DWG CC 3 Guideline B, where drainage requirements are needed. The manufacturer provides the object marker for this system and a marker post is not required due to the height of the system.

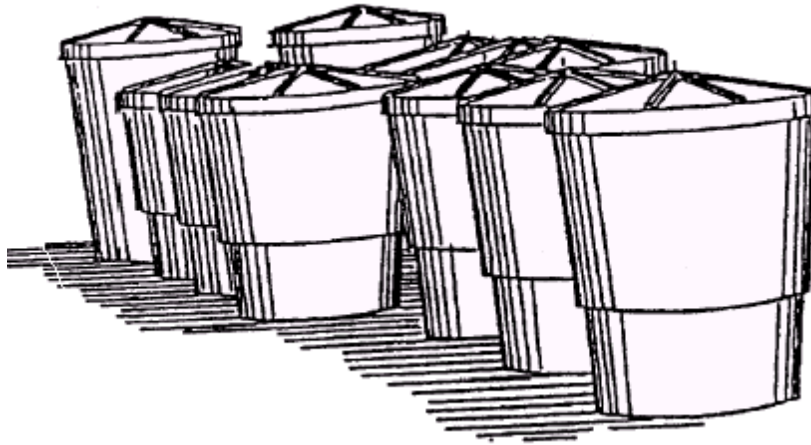
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Type E- Sand Barrel Arrays

To protect fixed hazards outside 15 feet of the traveled way where there is an unlimited amount of space. This system can be configured to meet varying width requirements. Use to protect concrete barrier ends, bridge parapets or piers, or other hazards as a stand-alone system. This system can be used in a work zone when the hazard being protected meets the 15 foot criteria.

Name: Three approved manufacturers.

1. **“Big Sandy” Traffix Devices Inc.**
www.traffixdevices.com
2. **Energite® III Barrels, Energy Absorption Systems**
www.energyabsorption.com/products/permanent/EnergiteIIISystem.htm
3. **Universal Barrels, Energy Absorption Systems**
www.energyabsorption.com/products/permanent/UniversalBarrels.htm



Sand Barrels

Length: Variable

Width: Variable

NCHRP Test Level: TL-1, TL-2, TL-3

(Designer to designate speed and width requirements)

Length of Need: Variable

Characteristics

Non-re-directive, uni-directional, bi-directional, gating, pocketing. This system uses plastic container filled with varying amounts of sand, which transfers and dissipates the energy from a impacting vehicle.

Application

Use to protect fixed objects outside 15 feet of the traveled lane.

Requirements

Refer to UDOT STD DWG CC 6 for pad and placement requirements The approach slope to the front of the system will be no greater 20:1 and free any obstacles for a length of 50 feet prior to the first barrel. The approach slope from the travel lanes to the sides of the system application will be no greater than 10:1 and be free of any obstacles. The required recovery area behind the system is 75 feet X 20 feet, and on a slope no greater than 4:1. Use Energite III Design Manual when designing this system (available from Division of Traffic & Safety). The manufacturer, supplier or installer of the system will provide the appropriate directional object panel UDOT STD DWG CC 1.

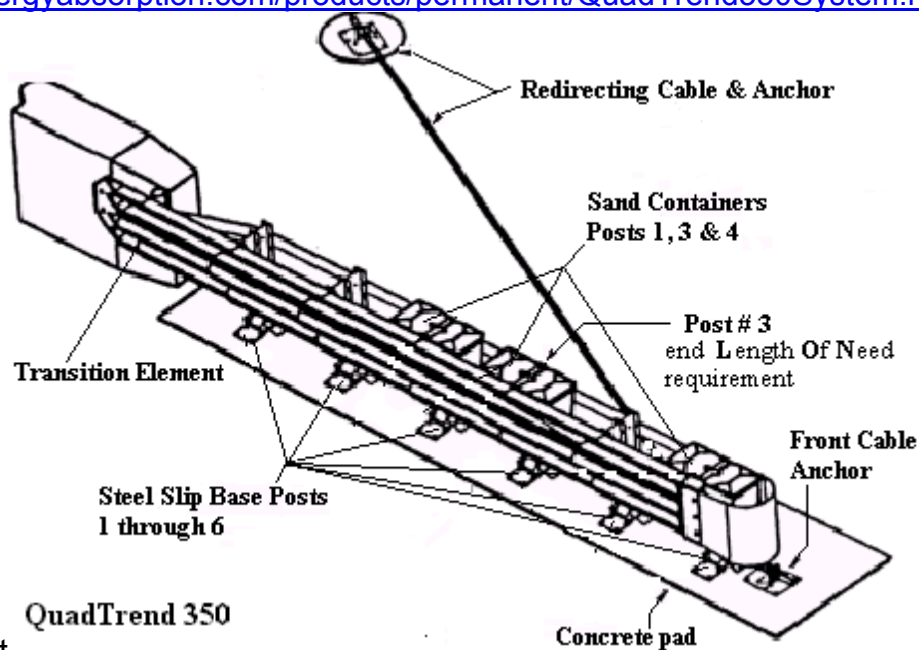
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Type F (1 approved system)

Use to protect concrete barrier or bridge parapet with less than 125 feet of longitudinal space in front of hazard.

Name: QuadTrend 350™ from Energy Absorption Systems

www.energyabsorption.com/products/permanent/QuadTrend350System.htm



Length: 21 feet

Width: 1 foot 3 inches

NCHRP Test Level: TL-3, may be used with any speed.

Length of Need: Starting at post # 3, 7 feet 6 inches from front of system (nose piece)

Characteristics:

Re-directive, uni-directional, gating. This system is equipped with a slip base steel post and sand containers, which work in conjunction with one another to dissipate the energy from an impacting vehicle.

Application:

Use to protect concrete barrier and bridge abutments with longitudinal space of less than 125 feet in front of hazard.

Requirements:

Construct concrete pad as per manufacturer's requirements. Use manufacturer's requirements for installing redirecting cable and cable anchor. Redirecting cable anchor will be positioned in such a manner as to allow the redirecting cable to lay

flat on the ground. Slopes of 10:1 or less are required to the front and side approaches, and be free of obstacles. Refer to UDOT STD DWG CC 7 Crash Cushion Type "F" for recovery area requirements and redirecting cable anchor requirements. The manufacturer, supplier or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD DWG CC 1.

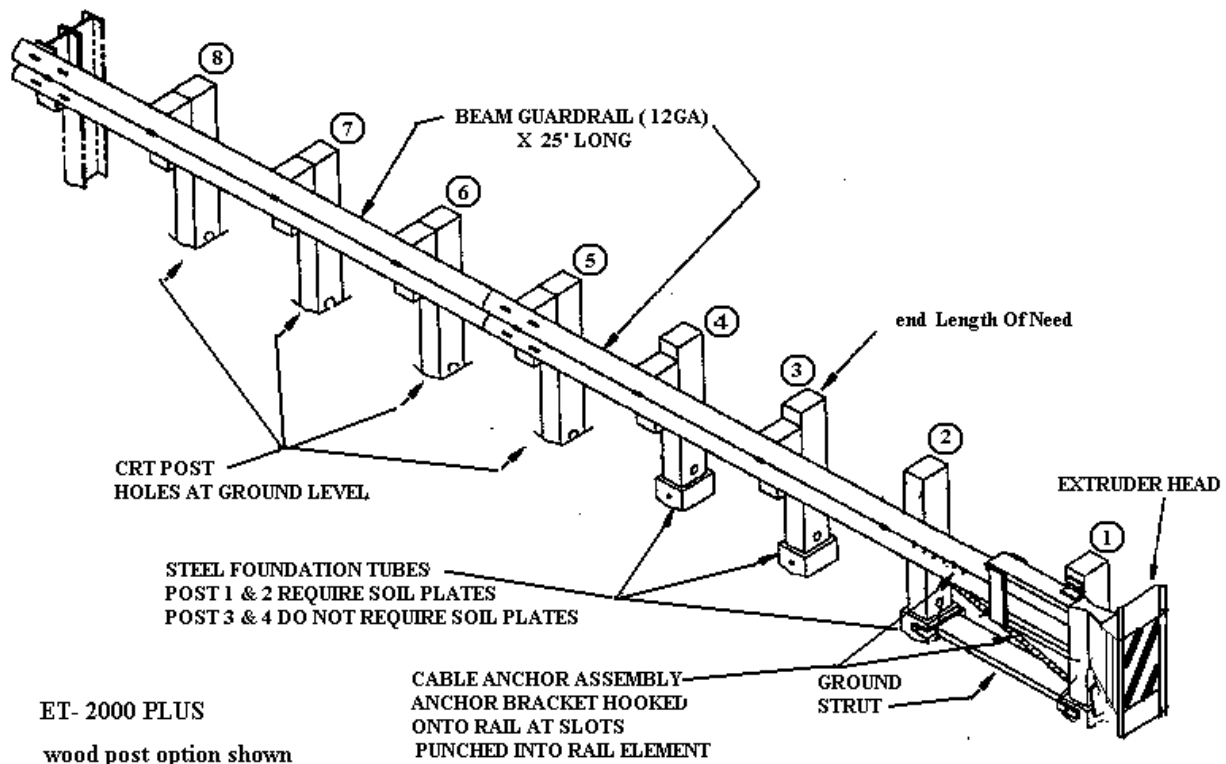
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Type G (Two approved systems. The systems in this type look very similar: see characteristics to distinguish differences.)

Use to protect the approach end of single face w-beam guardrail. Should be used to protect concrete barrier or bridge parapet with unlimited longitudinal space (125 feet or greater) in front of the hazard when proper transition element is installed. These systems used on tangent or flared barrier installations.

Name: ET-2000™ or ET-PLUS™ from Syro, Inc. A Trinity Industries Co.

www.highwayguardrail.com



Length: 50 feet

Width: 1 foot 8 inches (extruder head)

NCHRP Test Level: TL-3, may be used with any speed.

Length of Need: starting with post #3, 12 feet 6 inches from front of system

Offset: 50:1

Characteristics

Re-directive, unidirectional, gating. Extruder head flattens the rail, which is pushed out the backside of the head. The cable box anchor assembly is hung on

the first rail element using rectangular slots punched into the rail element. The extruder head chute **does not** extend to the cable box assembly attachment point. The extruder head appears to be solid.

Application

Single faced guardrail may be attached to bridge parapet or concrete barrier using a transition element, refer to STD DWG BA 4A. This system can be used with tangent or flared barrier installations.

Requirements

Line Post Options

Wood post:

Posts 1 and 2: 2 foundation tubes, 6 foot long, with shortened break away posts, 45 inches long. Post blocks not required at posts 1 and 2. Ground strut required between posts 1 and 2.

Posts 3 and 4: 2 foundation tubes, 4 foot 6 inches long, without soil plates and shortened break away posts, 45 inches long.

Posts 5 through 8: standard CRT posts

Foundation tubes will be no greater than 4 inches above ground line.

Steel post: Installation will use Hinged Breakaway steel posts (HBATM), as specified by Manufacturer.

This system uses W6 X 8.5 steel posts.

Posts 1 and 2: lower sections of Hinged Breakaway posts (HBATM) are 71½ inches in length, upper post are 28 inches in length. The post sections are bolted together. Post blocks are not required at posts 1 and 2. Ground strut required between posts 1 and 2.

Posts 3 through 8: lower sections of Hinged Breakaway posts (HBATM) are 43½ inches in length, upper sections are 28 inches in length. The post sections are bolted together. Notched wood or composite blocks are required at posts 3 through 8.

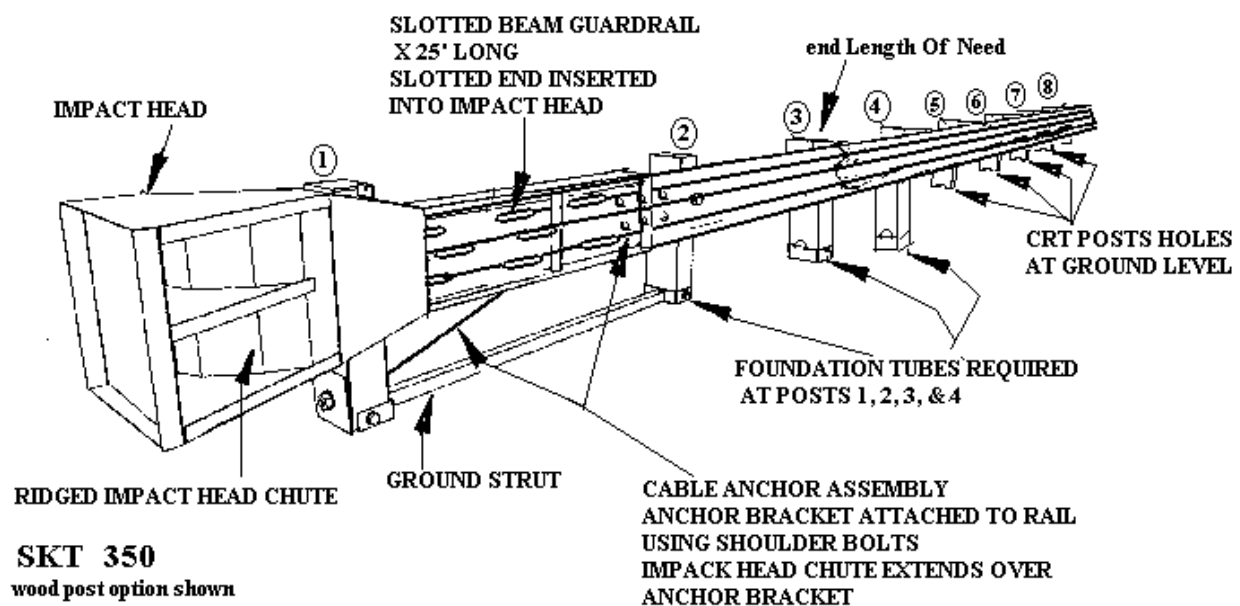
Hinge joint will be placed a maximum of 1 inch above ground line. Hinge section of post will not be placed below ground level.

The Hinged Breakaway Post (HBATM) used with this system cannot be substituted with any other type of steel breakaway post.

Transition required, as per UDOT STD DRW BA 4A for attachment to concrete barrier or bridge parapet, which will add a length of 25 feet to the installation. System will be installed with a 50:1 offset over the 50 foot length of the system. This will keep the extruder head from encroaching onto the shoulder of the roadway. The 50:1 offset may start at the connection point of the transition element if installed onto concrete barrier or bridge parapet.

Refer to UDOT STD DWG CC 8 Crash Cushion Type G for offset requirements, grading requirements and recovery area requirements. The manufacturer, supplier or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD DWG CC 1.

Name: SKT-350 from Road Systems Inc.,
www.roadsystems.com



Length: 50 feet

Width: 1 foot 8 inches @ impact head

NCHRP Test Level: TL-3 may be used with any speed.

Length of Need: Starting with post #3, 12 feet 6 inches from front of system.

Characteristics

Re-directive, unidirectional, gating. Extruder head kinks the rail element, which is pushed out the backside of the head. The cable box anchor assembly is attached to the first rail element using shoulder bolts and sliding over bolts. The extruder head chute extends to the cable box assembly attachment point. The extruder head is attached to the chute assembly leaving an open space between the face of extruder head and extruder chute.

Application

Single faced guardrail may be attached to bridge parapet or concrete barrier using a transition element, refer to STD DWG BA 4A. This system can be used with tangent or flared barrier installations.

Requirements

Line Posts Options

Wood post:

Posts 1 and 2: 2 foundation tubes, 6 foot long, and shortened break away posts, 45 inches in length. Post blocks are not required at posts 1 and 2. Ground strut required between posts 1 and 2.

Posts: 3 and 4: 2 foundation tubes, 4 foot 6 inches long, without soil plates and shortened break away posts, 45 inches long.

Foundation tubes will be no greater than 4 inches above ground line.

Posts 5, 6, 7, and 8: standard CRT posts, the bottom of the top hole will at ground level, post blocks are required at posts 3 through 8.

Steel posts: installation will use hinged breakaway steel posts, as per manufacturer's design requirements.

This system uses W6 X 9 steel posts.

Post 1: bottom section is 72 inches in length; upper section is 28 3/8-inches in length. The two sections are connected together using a bolt and plates, with a 1/4-inch gap between the two sections.

Post 2: bottom section is 72 inches in length; upper section is 29 7/8-inches in length. The two sections are connected together using a bolts and plates, with a 1/4-inch gap between the two sections. Ground strut required between posts 1 and 2.

Posts 3 through 8: bottom section is 41 1/2- inches in length; upper section is 30 1/4- inches in length. The two sections are connected together using a bolts and plates, with a 1/4-inch gap between the two sections.

Hinge joint will be placed a maximum 1-inch above ground line. Hinge joint of post will not be placed below ground level.

The hinge breakaway post for this system is manufacturer specific and other hinge breakaway post cannot be substituted.

Transition required, as per UDOT STD DWG BA 4A for attachment to concrete barrier or bridge parapet, which will add a length of 25 feet to the installation. System will be installed with a 50:1 offset over the 50-foot length of the system; this will keep the extruder head from encroaching onto the shoulder of the roadway. The 50:1 offset may start at the connection point of the transition element if installed onto concrete barrier or bridge parapet. Refer to UDOT STD DWG CC 8 Crash Cushion Type G for offset requirements, grading requirements and recovery area requirements. The manufacturer, supplier or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD DWG CC 1.

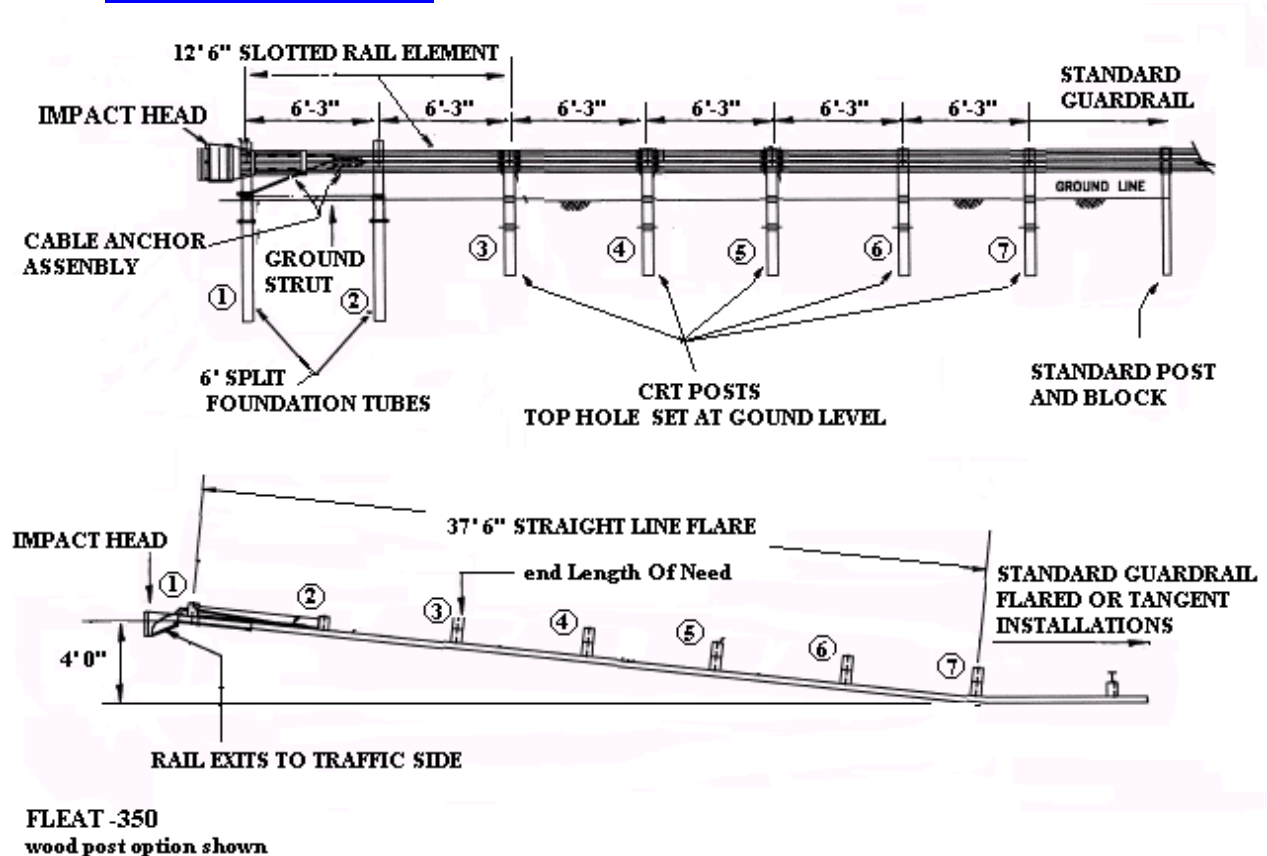
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Type H (3 approved systems)

Primarily used when protecting the approach end of single face w-beam guardrail. Should be used to protect concrete barrier or bridge parapet with unlimited longitudinal space 125 feet in front of the hazard when proper transition element is installed. These systems used on tangent or flared barrier installations.

Name: FLEAT-350 from Road Systems, Inc.

www.roadsystems.com



Length: 37 feet 6 inches

Width: 14 inches @ impact head

NCHRP Test Level: TL-3, may be used with any speed.

Offset

4 foot straight line flare over the length of the system. System post offset to be determined upon system layout. When system is used on a flared barrier installation, system will be installed at the same flare rate of the barrier

installation. When this system is used on a tangent guardrail installation the offset will be 4 foot.

Length of Need: Starting with post #3, 12 feet 6 inches from front of system

Application

Tangent or flared, single faced guardrail installations. When be used to protect concrete barrier or bridge parapet, a transition is required as per UDOT STD DWG BA 4A.

Characteristics

Re-directive, unidirectional, gating. The impact head slides over the rail element and when impacted the head kinks the rail element, absorbing the energy from the impacting vehicle, the rail is then pushed out the front side of the head. The cable box anchor assembly is attached to the first rail element using shoulder bolts and sliding over bolts.

Requirements

Line Posts Options

Wood post:

Posts 1 and 2: 72 inch split foundation tubes with 2, 45 inch wood breakaway posts. Posts 1 and 2 do not require a block. Ground strut required between posts 1 and 2.

Posts 3 through 7: standard 72 inch CTR posts, the bottom of the top hole will be place at ground level.

Steel posts:

Post 1 and 2 use 43 inch welded breakaway steel posts set inside 6 foot foundation tubes. Post 1 and 2 do not require a block. Ground strut required between posts 1 and 2.

Post 3 through 7: use 72" long welded steel breakaway post, joint of post will be placed a maximum of 1 inch above ground line. Joint of posts will not be placed below ground level.

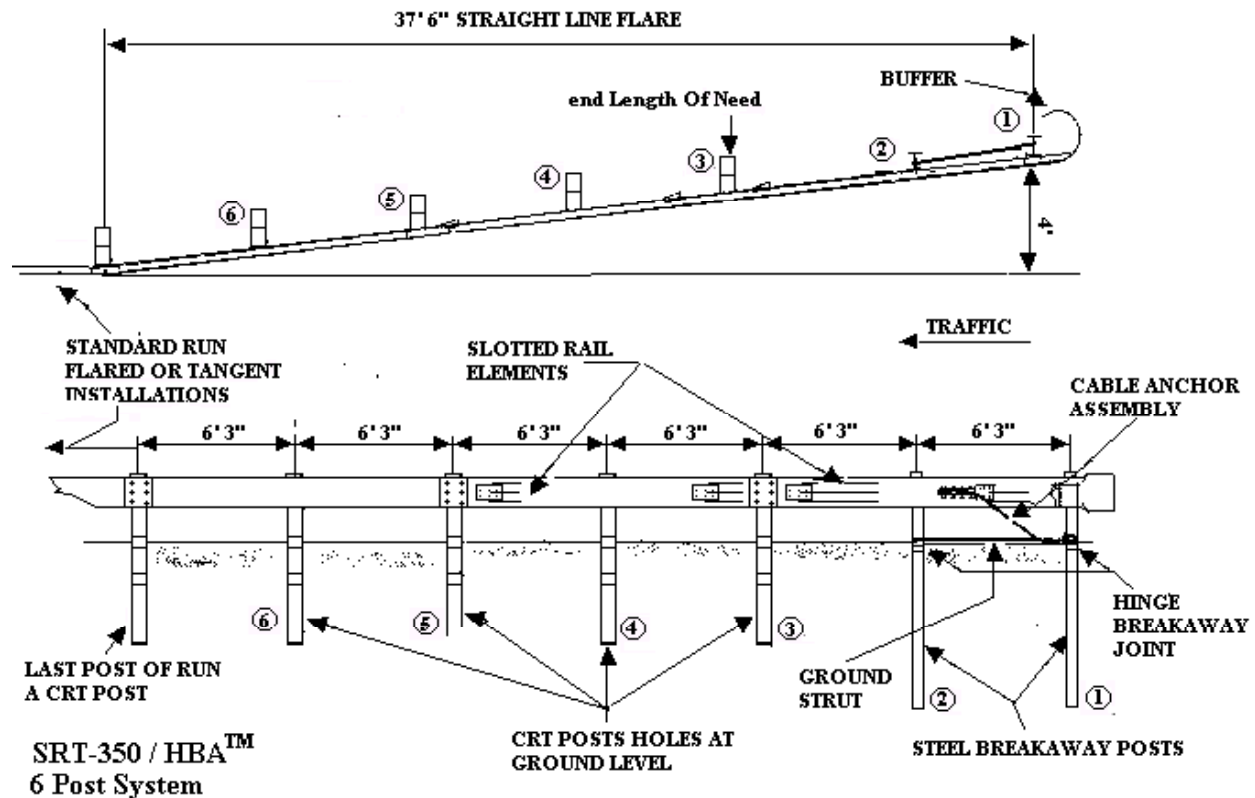
System to use only manufacturer's specified welded breakaway steel posts.

The foundation tubes will be no greater than 4 inches above ground level.

Transition required, as per UDOT STD DWG BA 4A, for attachment to concrete barrier or bridge parapet. Refer to UDOT STD DWG CC 9A Crash Cushion Type H for offset requirements, grading requirements and recovery area requirements.

The manufacturer, supplier or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD. DWG CC 1.

Name: **SRT™/HBA™ 6 Post System**, from Syro, Inc., A Trinity Industries Co.
www.highwayguardrail.com



Note: The last line post of the guardrail installation, at the point of the SRT-350/HBA is connected will be a CRT post and is not considered part of the system. When this system is bid and selected the contractor will insure that the CRT post at this location is installed.

Length: 37 feet 6 inches

Width: Width is same as standard guardrail

NCHRP Test Level: TL-3, may be used with any speed.

Offset

4 foot straight line flare over the length of the system.

Length of Need: Starting with post #3, 12 feet 6 inches from front of system.

Characteristics

Re-directive, uni-directional, gating.

Application: Single faced guardrail

Requirements

Posts 1 and 2: use Hinged Breakaway Post (HBA™) as supplied by the manufacturer. The posts are constructed in two pieces and bolted together at the hinge point. The lower sections are 71 1/2- inches in length and the upper section is 43 1/2-inches in length. Post 1 and 2 do not require a block. Ground strut required between posts 1 and 2.

The Hinged Breakaway Post (HBA™) used with this system cannot be substituted with any other type of steel breakaway post.

Post 3 through 6: standard 72 inch CTR posts, the bottom of the top hole will be placed at ground level.

The last post of the guardrail run will use a standard CRT post with a block out and is not considered part of the system.

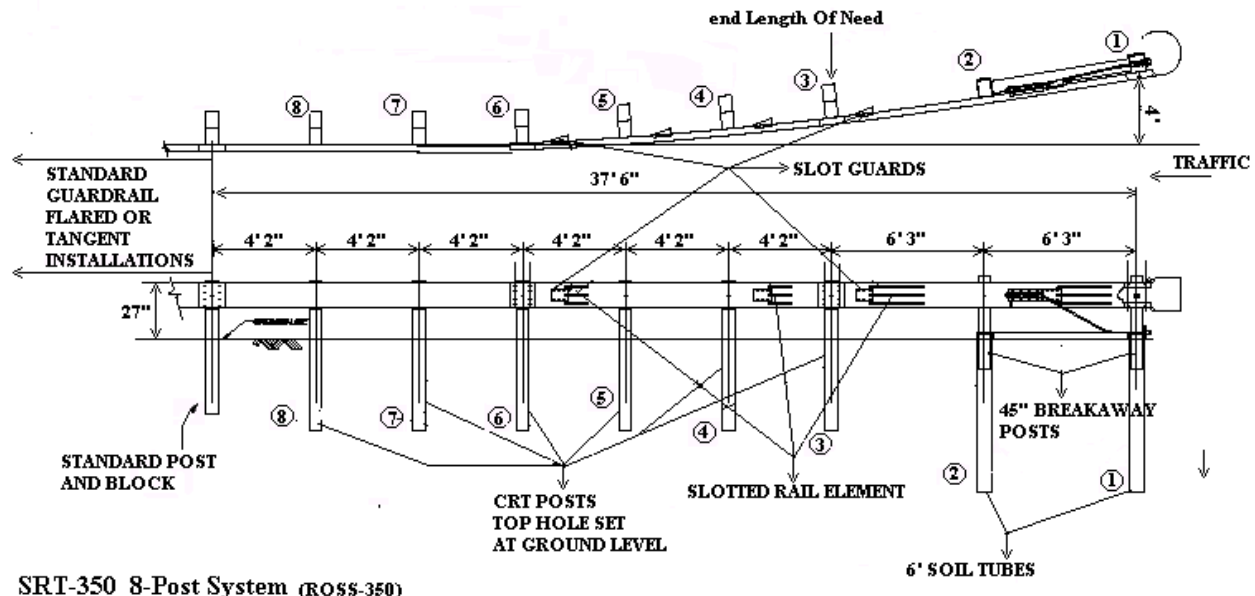
Transition required, as per UDOT Standard Drawing BA 4A, for attachment to concrete barrier or bridge parapet. ~~An additional 12'6" is required at the end of the transition element in order to meet the requirements of this system with the CRT post as the last post of a guardrail run.~~ Refer to UDOT Standard Drawing CC 9A, End Section Type "H", for grading and recovery area requirements. The manufacturer, supplier or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD. DWG CC 1. **(Double strikeout per Pen and Ink change dated May 12, 2003 by SAF)**

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Type H (continued)

Name: SRT-350™ 8 Post System, from Syro, Inc., Trinity Industries

www.highwayguardrail.com



SRT-350 8-Post System (ROSS-350)

Length: 37 feet 6 inches

Width: Width is same as standard guardrail

NCHRP Test Level: TL-3, may be used with any speed.

Length of Need: Starting with post #3, 12 feet 6 inches from front of system.

Offset:

4 foot parabolic flare over the length of the system.

Characteristics:

Re-directive, uni-directional, gating

Application: Single faced guardrail

Requirements:

Posts 1 and 2: 72 inch foundation tubes with 2, 45 inch wood breakaway posts. Posts 1 and 2 do not require a block. Ground strut required between posts 1 and 2.

Posts 3 through 8: standard 72 inch CTR posts, the bottom of the top hole will be placed at ground level.

The foundation tubes will be no greater than 4 inches above ground level.

Transition required, as per UDOT Standard Drawing BA 4A, for attachment to concrete barrier or bridge parapet. Refer to UDOT Standard Drawing CC 9B, End Section Type "H", SRT-350, for grading and recovery area requirements. The manufacturer, supplier or installer of the system will provide the appropriate directional object panel and marker post, UDOT STD. DWG CC 1.

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Construction Zone Systems

The following are approved construction zone systems, to be supplied by the contractor in most cases.

Not all the systems are NCHRP 350 approved but may be used until such time the service life has expired.

Construction Zone Crash Cushions		
Name	Manufacturer	NCHRP Test Level
ABSORB 350®	Barrier Systems Inc.	TL-2 \leq 45 MPH, 5 element TL-3 > 45 MPH, 9 elements This is a gating system and a recovery area behind the system of 75' x 20' is required. Recovery area will not have a slope greater than 4:1. When used in freezing conditions an antifreeze solution is required. Fill liquid will be pumped in and out. No fill liquid emptied onto roadway or in the right of ways.
ADIEM 350™	Trinity Industries, Inc.	TL-3 any speed
ADIEM II™	Trinity Industries, Inc.	TL-2, \leq 45 MPH
NEAT®	Energy Absorption System	TL-2, \leq 45 MPH This is a gating system and a recovery area behind the system of 75' x 20' is required. Recovery area will not have a slope of greater than 4:1.
QuadGuard CZ™	Energy Absorption System	TL-2 \leq 45 MPH 3 bay system TL-3 > 45 MPH 6 bay system

Construction Zone Crash Cushions

Name	Manufacturer	NCHRP Test Level
REACT 350	Roadway Safety Services, Inc.	TL-1, < 45 MPH 4 cylinders TL-2, ≥ 45 MPH ≤ 55 MPH 6 cylinders TL-3, > 55 MPH 9 cylinders
TAU-II™	Barrier Systems Inc.	TL-2, ≤ 45 MPH 4 bay system TL-3 > 45 MPH 8 bay system
SHORTRACC™	Trinity Industries	TL-2, ≤ 45 MPH
TRACC™	Trinity Industries	TL-3 any speed
<u>Sand Barrels</u> “Big Sandy” Energite III® Universal Barrel®	TrafFix Devices Inc. Energy Absorption Roadway Safety Services	TL-1, TL-2, TL-3 When using this system all installation requirements as per a permanent application will be met. See Type E permanent crash cushion
GREAT CZ® This system is not an NCHRP 350 approved system. It may be used until service life has expired.	Energy Absorption System	Speed ≤ 45 MPH, 3 bays Speed > 45 MPH, 6 bays

DOCUMENT SOURCES

NCHRP Report 350 - Recommended Procedures for the Safety Performance Evaluation of Highway Features

NCHRP Report 230 - Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances

NCHRP Synthesis 205- Performance and Operational Experience of Crash Cushions

Design Construction and Maintenance of Highway Safety Features, NHI, 1997

Guide to Standardized Highway Barrier Hardware, Task Force 13 Report, AASHTO

Roadside Design Guide, 2002, AASHTO

Energy Absorption Systems, Inc., Design and Installation Manuals

Energy Absorption Systems, Inc., Safety Needs Analysis Program (SNAP)

Road Systems, Design and Installation Manuals

Trinity Industries Inc., Design and Installation Manuals

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